Network interoperability and QoS for smart homes

Ye-Qiong Song

Loria
Laboratoire lorrain de recherche en informatique et ses applications

INRIA
INVENTEURS DU MONDE NUMÉRIQUE

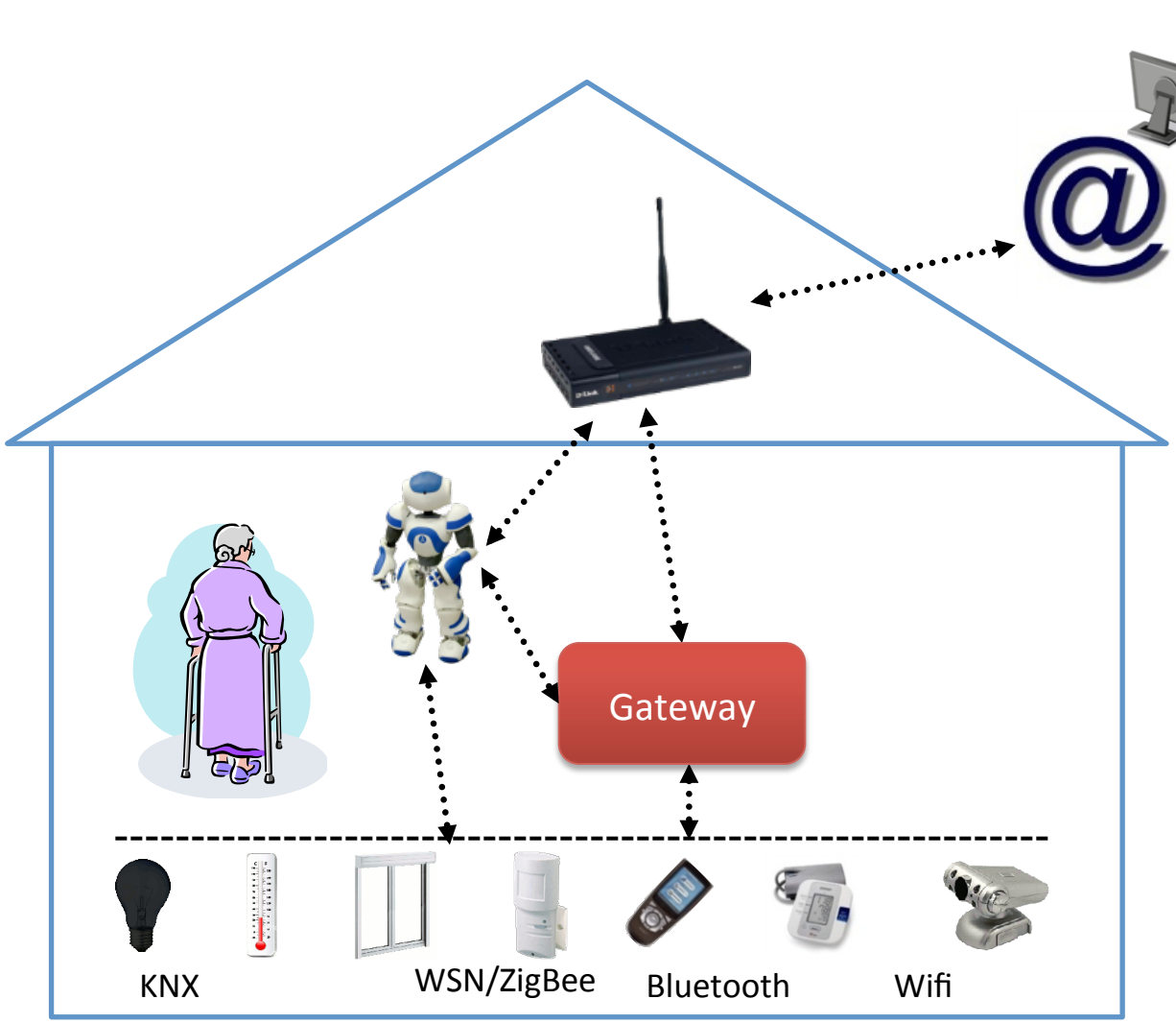
Network interoperability and QoS for smart homes

By:

Ye-Qiong SONG

TRIO team, LORIA/INRIA NGE – INPL Nancy

Context: Smart home for elderly

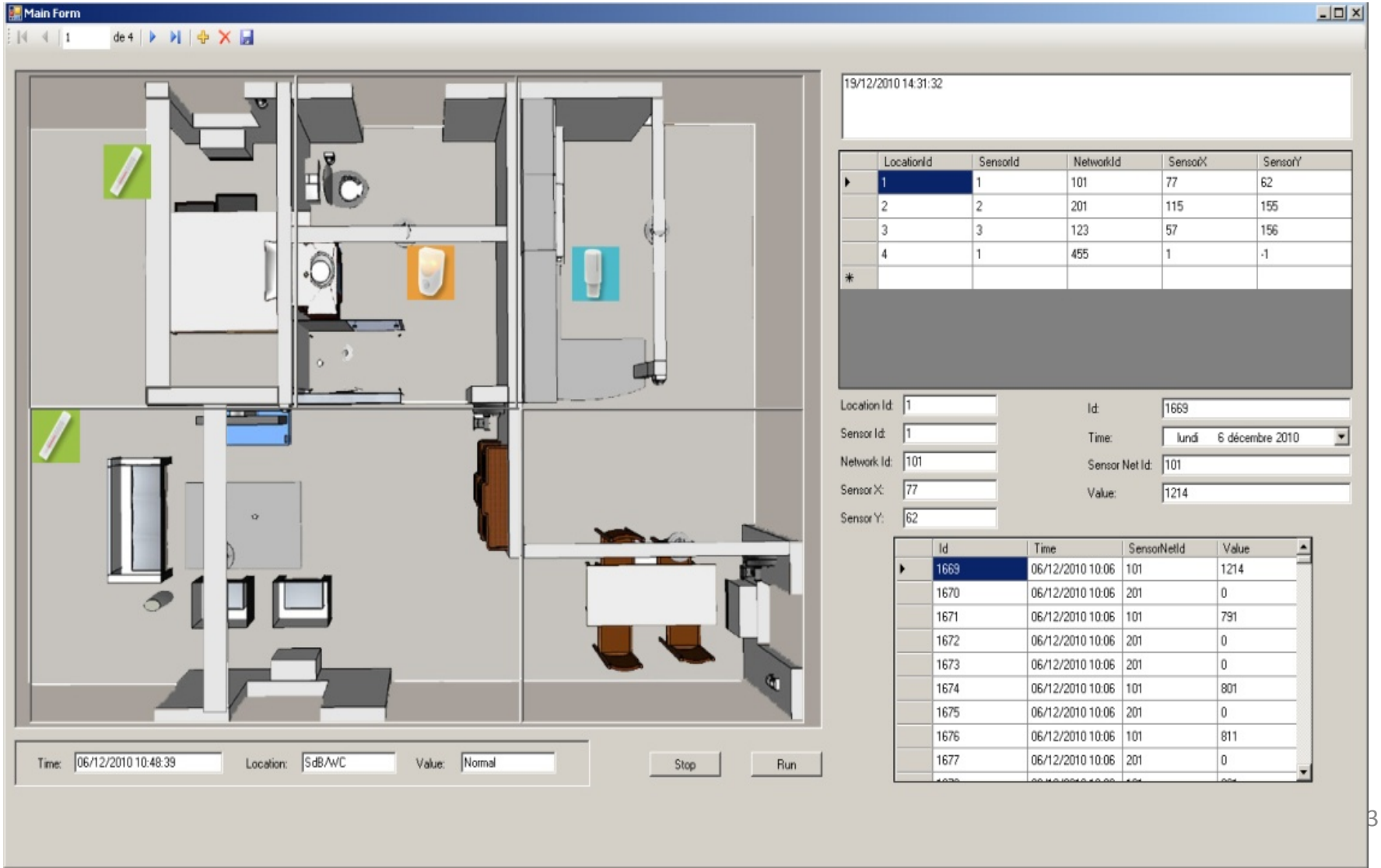


TRIO internal projects:
- QoS for WSN
- MPIGate

INRIA PAL project and sooner ADT PERCEE

LORIA Smart home project (CPER Lorraine)

LORIA smart apartment for concept and technology validation



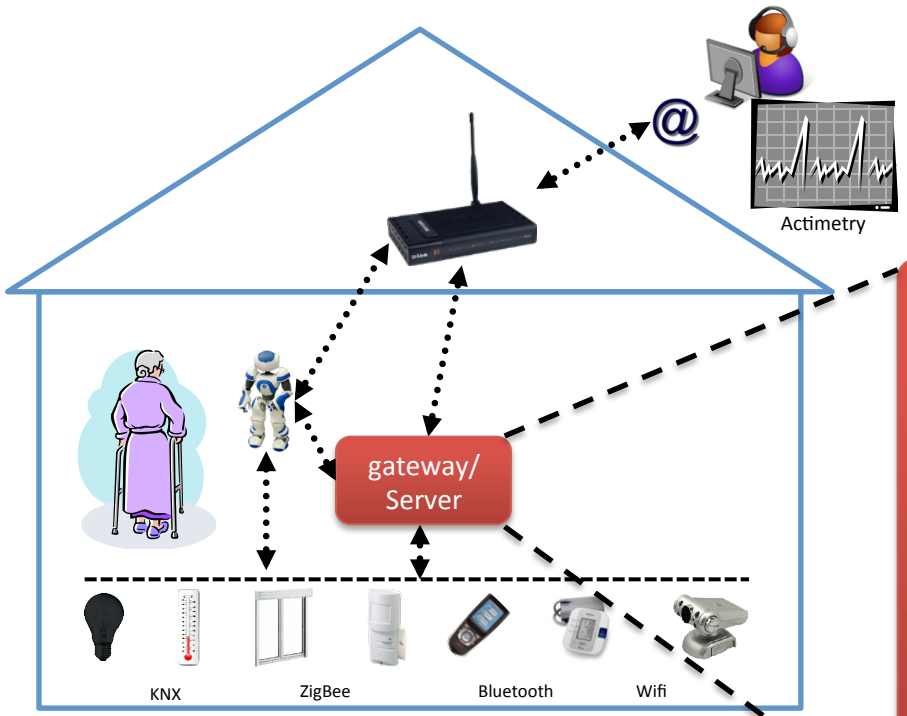
Main R&D topics and our approaches

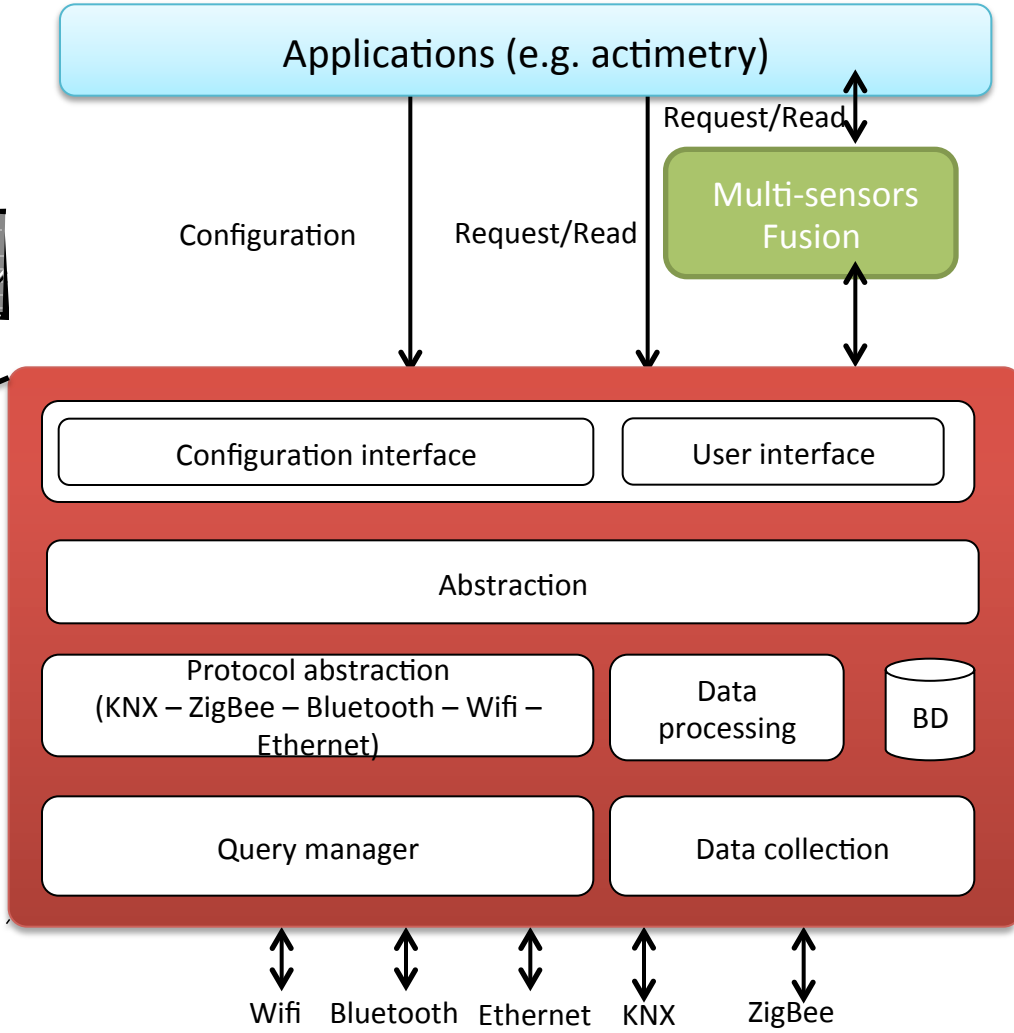
- Interoperability of heterogeneous communication protocols
  - A communication **gateway**
- Easy data access
  - A middleware-based **interface** over gateway
- QoS support (in both WSN and the whole heterogeneous network)
  - **QoS** mechanisms in WSN (IEEE802.15.4/Zigbee)
  - QoS management at the gateway/middleware

MPIGate:

Multi Protocol Interface and Gateway

for Tele-homecare, Environment Monitoring and Control





MPIGate - Components

- **Configuration manager:** is an interface to configure different parameters of the system. By using this interface one can provide and modify necessary information to process the data in “Data processing layer”.
- **User interface:** provide a graphical user interface for the user to visualize the state of each sensor and actuator, their historical information and the reports generated by the system.
- **Abstraction:** this layer hides the heterogeneity of the system for the users, by providing communication facilities between the interface layer and the other parts of system. The user doesn’t need any prior knowledge of the protocols behind the system.

MPIGate - Components

- **Data processing:** this layer is the main part of the system. It process the information collected from the network and save the results in the data base.
- **Query manager:** receives the query from user interface, create the query and sends them to the network. The query might be a command to control an actuator or a request to read a sensor data.
- **Protocol abstraction:** provides necessary information about each communication protocol used in the network.
- **Data collection:** collects the data from the network and send them to the data processing layer.

QoS requirements

- QoS at gateway
  - Service differentiation
  - For time-constrained data exchanges (e.g. sensor-network-robot loops, home automation control, alarms, …)
    - E2E delay specification and verification
    - Time consistency for multi-sensor data
- QoS at WSN
  - Reliability and E2E delay under stringent power constraint

QoS in WSN

- QoS-aware MAC protocols for low power WSN
- Multi-hop WSN for increasing transmission reliability (even for in door applications)
- QoS-aware and energy-aware routing protocols

Example of CoSens over IEEE802.15.4, an auto-adaptive QoS mechanism
(PhD work of B. Nefzi, LORIA – INPL)

CoSens principle

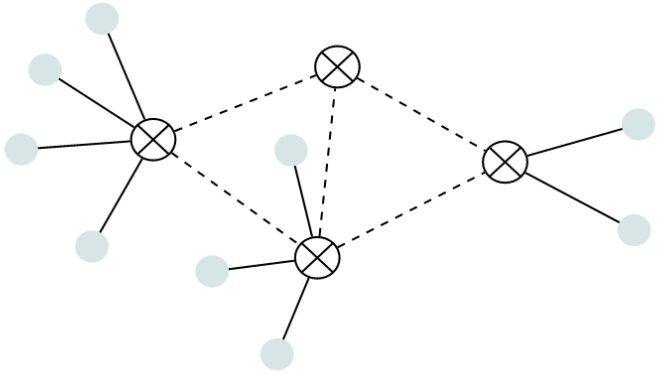
- CSMA/CA is a widely spread MAC protocol (used in IEEE802.11x and 15.4)
- Bad performance under heavy load
- CoSens (Collect and Send Burst) scheme
  - improves the performance of CSMA/CA
  - resolves the problem of scheduling difficulty

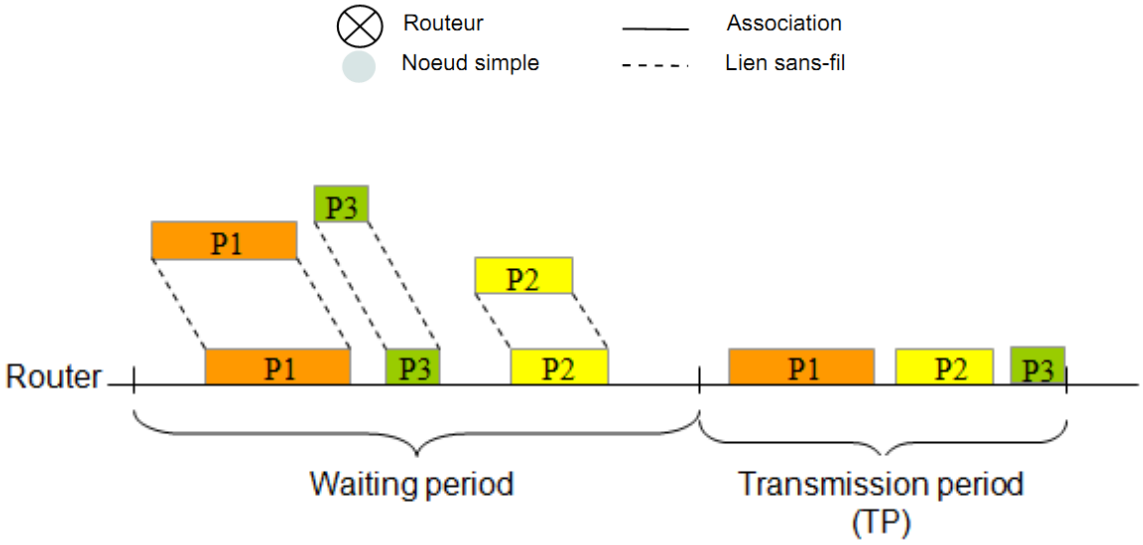
CoSens Principle

Architecture 2-tiers: simple nodes and routers

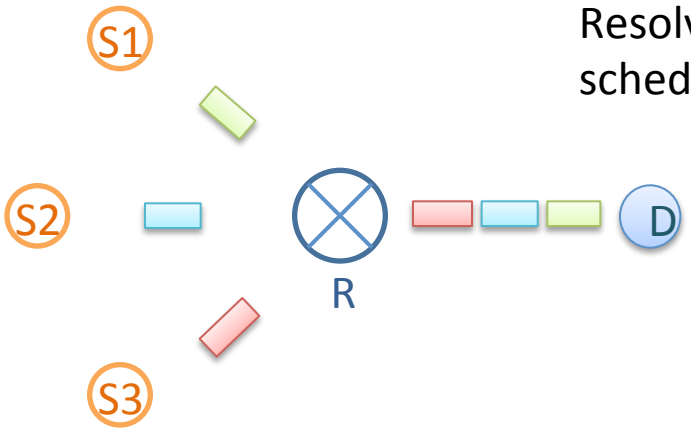
Router working cycle: WP + TP

Dynamic WP adjusting according to the on-line traffic estimation algorithm (sliding exponential average)

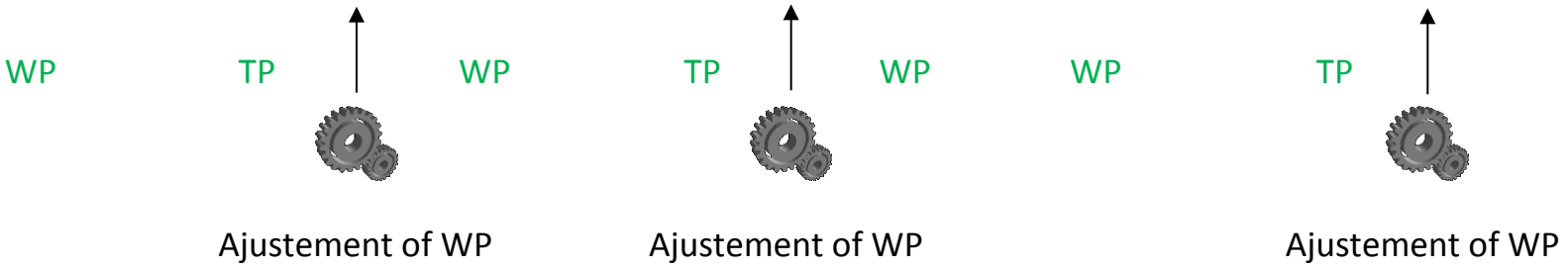




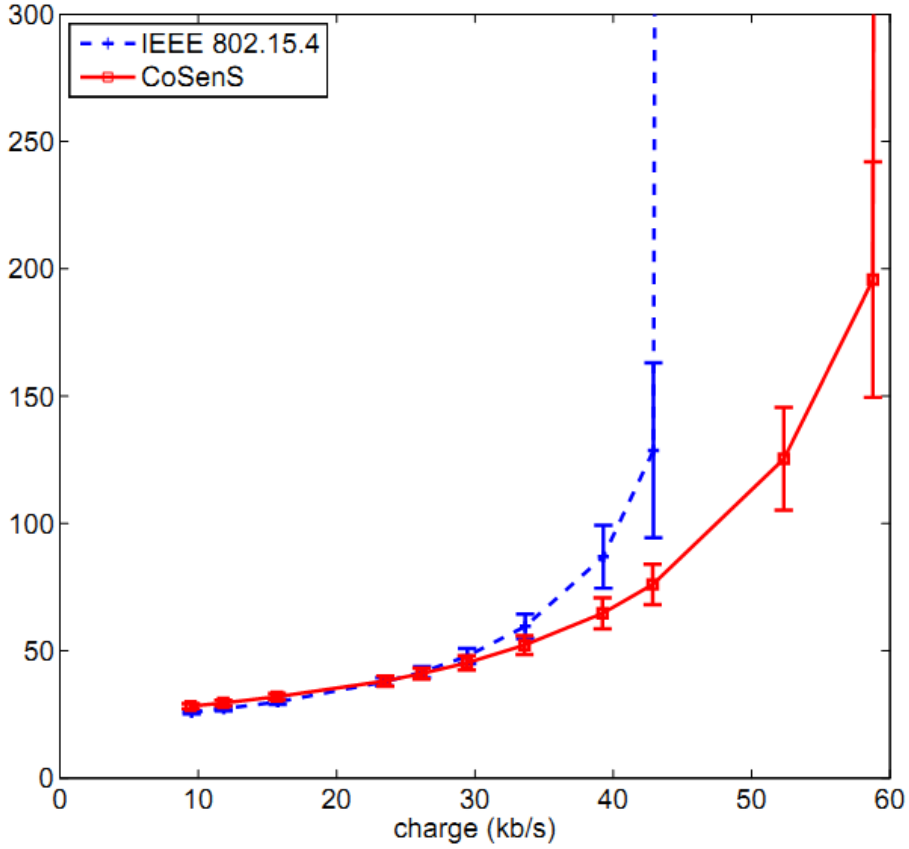
CoSens principle



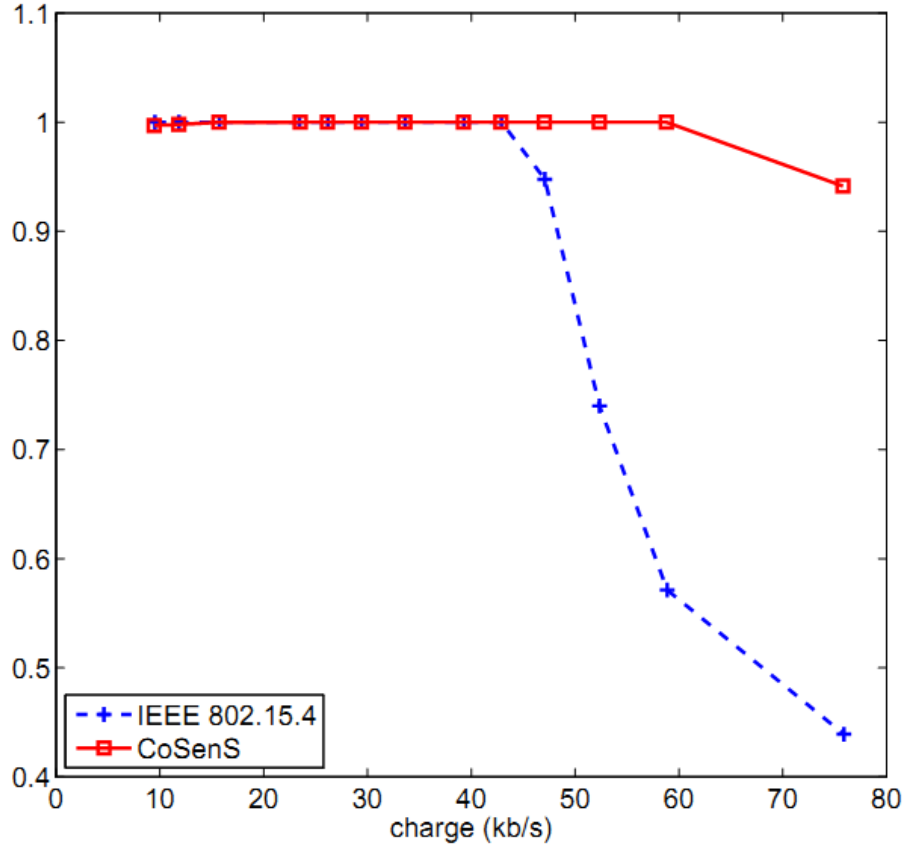
Resolve the problem of scheduling difficulty



Cosens performance



E2E delay vs. load



Tx success rate

Concluding remarks

- WSN represents a promising technology for smart homes but reliability and QoS remain to be enforced.
- Still very limited IEEE802.15.4/Zigbee devices
- Several wireless protocols co-exist for still long time → need of gateway solutions
- From AAL application point of view, it lacks an open development platform (see UniversAAL efforts)
- WSN tightly interacting with mobile robots calls for further research efforts

Some references

- H. Alemdar, C. Ersoy, “Wireless sensor networks for healthcare : A survey”, *Computer Networks* 54 (2010) 2688-2710.
- JeongGilKo; Chenyang Lu; Srivastava, M.B.; Stankovic, J.A.; Terzis, A.; Welsh, M.; “Wireless Sensor Networks for Healthcare”, *Proceedings of the IEEE*, Nov. 2010, Vol.98 (11), p. 1947 – 1960
- Li Y., Chen C.S., Song Y.-Q., Wang Z. Sun Y., “Enhancing real-time delivery in wireless sensor networks with two-hop information”, *IEEE Transactions on Industrial Informatics* Vol.5, No.2 (May 2009), pp113-122.
- B. Nefzi, Y.-Q. Song. "QoS for Wireless Sensor Networks : Tackling Service Differentiation in MAC sub-layer", AdHocNets 2010.
- B. Nefzi, Y.-Q. Song. "CoSenS : a Collecting and Sending Burst Scheme for Performance Improvement of IEEE 802.15.4".35th Annual IEEE Conference on Local Computer Networks and Workshops, LCN 2010.
- S. Nourizadeh, “A context-aware and QoS-aware telehomecare system”, PhD Thesis, INPL, July 2011
- LORIA smart apartment: http://infositu.loria.fr
- UniversAAL http://universaal.org/

Thank you for your attention!